# 2016/2017 Requirements for Senior

# University High School AP Statistics Research Papers

The paper is to be written in past tense, using uniform font size 12, written in third person with section titles bolded and subtitles underlined. Since the page will be left bound, remember to have a 1.5 inch left margin. Do not use contractions. Alphabetized names appear as headers with a hyphen between names. Use page numbering with the **Introduction being Page 1**. Projects are to be original research or, with approval, extensions of previous research.

**1. Title Page must include:**

**Title**

Your Name

University High School

Class

Ms. Danielle Mozal

Due Date

2. **Abstract**

The abstract consists of concise summary (no more than one page. It includes accomplished objectives, methods, results, and conclusions. The abstract helps the reader understand the relevance of the study. This page is NOT numbered and the title is the **title of the paper** and is centered.

3. **Table of Contents**

This section should consist of a complete table of contents listing all the parts of the paper and their correct page number. No page number or header needed.

1. **Introduction**

This section sets the stage for your scientific argument. It places your work in a broad theoretical context and gives readers enough information to appreciate your objectives. A good Introduction ‘hooks’ its readers, drawing them into the project and its potential significance to the scientific community and/or the general population. The writer must have a firm grasp of the aims, principal results and relevance of the research. You may find that the Introduction is easier to write *after* you have written other portions of your paper and have a clearer understanding of just what you are introducing.

Some questions to consider when writing an Introduction:

* What is your project about?
* What is the general method being used to carry out the project?
* How is your project of value to the scientific community?
* What are the practical applications of your research?

***IMPORTANT POINT***: The Introduction is about how your project fits into the global scientific perspective. The Review of Literature pertains to the SCIENCE that SUPPORTS your project.

5. **Review of Literature**

The purpose of this section of your paper is to discuss all the scientific information necessary to understand your topic. The Review of Literature includes an explanation of the progression of relevant research and related experiments in your field of study, and what methods were used by predecessors who have already studied this topic and the results of their work. Briefly mention how your approach varies from previous investigators. Your Review of Literature should help you formulate a good problem statement and give you a foundation from which to model your experimental testing. This is where you must educate the reader to the SCIENCE involved. Consider your target audience and define or explain any terms, formulas (see Appendix C for format) and concepts that are critical to understanding this section. For example, do not just state that you poured a chemical into the dirt and the roots absorbed the liquid. You MUST explain the **science** of HOW this happens.

The Review of Literature should be long enough to be thorough and short enough to avoid repetition.

6. **Problem Statement**

Problem Statements will be reviewed by Ms. Mozal **prior to final approval**. This should be a clear statement of the specific problem which was studied and the hypothesis made by your team. This part will consist of three labeled and underlined subsections:

Problem: A short, concise description of the problem.

Hypothesis: Generally one sentence in length, although it may be up to one paragraph. It is a statement of what is being tested, and generally takes the form of an If-Then statement.

Data Measured: You are to identify the independent and dependent variables, units of measure for ***each*** variable, and the intended statistical analysis. Write this section in complete sentences.

7. **Data and Observations**

This is where you will directly report the raw data, converted data with a single sample calculation shown where appropriate, along with any observations you made during the experiment which may have impacted the quality of the results. Place observations in a table format as close as feasible to the data that they describe. Include photographs of the experiment in progress (either before and after pictures OR pictures of the experiment in chronological order, whichever is appropriate). You should show any formula used to calculate values shown in your data table with all variables defined. Show any preliminary calculations needed before data analysis in an Appendix. (See Appendix C for sample calculation format) This section does not interpret, compare, or contrast the data. It does not have conclusions.

8. **Data Analysis and Interpretation**

Use this section to calculate and report any statistical analysis you have performed with your data. This is where graphs, modeling, curve fittings, and/or statistical tests appear. Include a sample of all calculations for determining a derived value used in an appendix. See specific requirements for this section in Appendix A of this manual.

9. **Conclusion**

This section is the most vital section of your paper and deserves your utmost attention. It is used to summarize the general conclusions drawn from your experiment. Experimental strengths, scientific relationships, patterns, and arguments that you have been building up in your paper, all come together in this section. The length of this section is two to three pages.

* Briefly state your conclusion with an appropriate statistic or percent error. Specifically, tell the reader what your findings mean, supported with scientific and/or experimental evidence.
* Explain **WHY** the results occurred. Explain these results scientifically. Tell whether your results agree or disagree with current research you referenced in your review of literature and explain **WHY**.
* Discuss any weaknesses in the design of the experiment, and any sources of error that affected the results. You must go beyond human error and dig into the realm of science. Make no apologies or excuses; take responsibility for your conclusions and results (positive or negative)!
* How do your results impact the scientific community? What further research could be conducted to study the problem further or to improve upon the study of this problem?

10. **Acknowledgments**

Express your appreciation to people who assisted you with your paper or research project. This page is optional.

11. **Appendix**

Page has a header and is numbered. Not all projects will require an Appendix.

12. **Work Cited**

Contains all references used in paper and should be presented in correct MLA style and support any parenthetical citation used throughout the paper.   
Entries are double spaced; page has a bolded title and is numbered. Ten sources must be cited throughout your paper. Five must be peer reviewed and one must be your professional contact. As proof, an e-mail from the contact must be included as an appendix in your paper.

**Appendix A**

**Descriptive and Another Statistical Treatment:**

1. Include Plot(s) of the data (histogram, box plots, line graphs, etc.).

2. Comment on any trends, patterns, etc. present.

3. State Mean & standard deviation of each set, if appropriate.

4. Find a model, if appropriate.

Specific requirements (see below)

One-sample *t* test

5. If less than 30 data points, plot the data and show that there are no outliers or skewness. (If there are, the t-test does not apply. Do descriptive analysis only.)

6. Clearly state the standard and the sample.

7. State the null and alternative hypotheses. Use mathematical notation and

identifying subscripts.

8. Show the graph and explain the p-value in relation to your problem (*t* test screen and graph).

Two-sample *t* test

5. If less than 30 data points, plot the data and show that there are no outliers or skewness. (If there are, the t-test does not apply. Do descriptive analysis only.)

6. State the null and alternative hypotheses. Use mathematical notation and

identifying subscripts.

7. Show the graph from the calculator and explain the p-value in relation to your problem (*t* test screen and graph).

Chi-Square

5. State the null and alternative hypotheses. Use mathematical notation and

identifying subscripts.

6. Include table of experimental values.

7. Include table of expected values & source of data.

8. Show calculation of chi-squared, df, and approximate p-value.

9. Interpret p-value in relation to your problem

Formulas for all statistical tests should be shown and detailed in an appendix. Also a sample calculation should be given. For example if you a performing a *t* – test you would show the equation for it and also define each variable in the anchor.

*t =* – µx  *t* = 17 - 20 = -5.5

s/√n 3/√30

Figure 5. *t* – Test Formula and Sample Equation

This equation calculates the value *t* which represents the number of standard deviations above or below the mean that average data lie in a *t* distribution. The mean of the sample is represented by , Mu,µ,shows the standard value that is being compared to, n represents the sample size and s is the sample standard deviation.

Formulas for derived scientific values and a sample equation must also be included here in the appendix. For example, if you are trying to find the density of a certain metal but you are measuring the mass and displacement of water volume in your experiment you need to show how you calculated density from the final volume and mass that you recorded in your data table.

D = m D = 38 g = 7.6 g/ml

V 5ml

Figure 6. Density Formula and Sample Equation

The density of the element is calculated using the equation above, where D represents…

**Senior Research Contract**

Names: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Proposed Problem Statement:

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Brief description of your experiment:

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Independent variable: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Dependent variable(s): \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Number of trials: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Detailed Plan for randomization. (Do not just state, “with my calculator.”)

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Proposed statistical treatment:

\_\_\_Descriptive **AND** \_\_\_\_1-Sample *t* Test \_\_\_ 2-Sample *t* Test \_\_\_Chi-Square

\_\_\_ Other (Specify)

Describe why your choice is appropriate for your research.

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Approvals:

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Ms. Mozal Student

**Appendix B**

**Example of Embedded Formulas in Text:**

Plank gave the name quantum to the smallest energy that can be emitted or absorbed. He proposed that energy, E, of a signal quantum number equals a constant, h, times its frequency, ν.

E = h ν

Plank then set about….(Continue paragraph here).

**Example of Sample Calculations in Text:**

To analyze our data we needed to use the following equation where energy, E, of a single quantum number equals a constant, h, 6.623 x 10-34 Js, times its frequency, ν.

E = h ν

Shown below in Figure 1, is a sample calculation using the equation for the energy of a photon.

E = h ν

= (6.623 x 10-34 Js)(5.09 x 1014 s-1)

= 3.37 x 10-19 J

Figure 1. Energy Equation

The results showed that … (Proceed with the rest of your paper here).

**Appendix C**

**What is an Annotated Bibliography?**

An annotated bibliography is a list of citations to books, articles, and documents. Each citation is followed by two brief (usually about 150 words) paragraphs, descriptive (summary) and evaluative (critique). The purpose of the annotation is to assist you in writing your review of literature, as well as evaluating the relevance, accuracy, and quality of the sources cited.

**Why Is This Useful?**

An annotated bibliography provides specific information about each source you have found. As a researcher, you need to become an expert on your topic and have the ability both to explain the content and to assess the usefulness of your sources. Think of your annotations as part of a conversation with yourself. The annotated bibliography reminds you about potential topics to investigate, what might be worth investigating further and what might not be worth spending your time on. You want to give yourself enough information to understand basically what the article/topic is about and to make an informed decision about whether this source is creditable.

**A Good Annotated Bibliography Will:**

* Encourage you to think critically about the content of the works you are using, their place within a field of study, and their relation to your own research and ideas.
* Prove you have read and understand your sources.
* Establish your work as valid and you as a competent researcher.
* Orient your study and topic in a continuing professional research.
* Provide a way for others to decide whether the source will be helpful to their research if they read it.
* Help you as a researcher determine whether you are interested in a topic by providing background information and an idea of the work going on in a field.

**The Process:**

Creating an annotated bibliography calls for the application of a variety of intellectual skills: concise exposition, succinct analysis, and informed library research.

First, locate and record citations to books, periodicals, and documents that may contain useful information and ideas on your topic. Briefly examine and review the actual items (start with the abstracts). Then choose those works that provide a variety of perspectives on your topic.

**Format:**

You will need 15 annotations, which may range from ½ -1 page each. For each annotation you must complete the following:

1. Cite the book, article, or document using MLA style. (<http://owl.english.purdue.edu/owl/resource/557/02/>) or (<http://citationmachine.net/>)

2. Write a concise summary of the central theme and scope of the book or article IN YOUR OWN WORDS. Do not copy the abstract. The following are ideas to consider as your write your annotated bibliography:

* What are the main arguments, thesis, or hypothesis?
* Give an overview of the arguments and proofs/evidence addressed in the work and the resulting conclusion.
* Do not judge the work they are discussing. Leave that to the critique.
* When appropriate, describe the author's methodology or approach.

3. Critically appraise and analyze the sources for your specific purposes.

* Evaluate the source or author critically (biases, lack of evidence, objective, etc.).
* How is this source beneficial/useful to your project, why?
* State the credentials of the source or the publication.

**Example:**

Vegetables Today. NASA. September 2007/ Version 003. September 8, 2007 <www.vegatablestoday.net>.

**Summary:**

This article describes a rapid and effective method for identifying vegetable oils from a variety of fibers, including cotton. The method uses ethanol to wick the oil from the cotton fiber. Due to the organic composition of both the oil and the ethanol basic solubility rules are utilized. The author hypothesizes that this method of oil removal is 99% effective and maintains the integrity of the sample for analysis.

**Critique:**

The author uses a controlled comparative experimental method and has evidence from completing many replications of his experiment. The author is Dr. Frankenstein from the Cambridge Laboratories and published in the Royal Journal of Science. We are going to use some of his procedures in our experimental design, specifically steps 3, 5, and 7, and compare the results of our experiment to his results.